Refuelable Battery for Fleet Electric Vehicles

Zinc-fuel battery provides electric vehicles with long range and rapid refueling

We developed a zinc-fueled battery that can provide electric vehicles with the essential functions of internal combustion vehicles: long range (400 km), safe acceleration, and rapid refueling (10 min). This battery's long range is the result of a five-fold increase in useful energy density compared with conventional lead-acid batteries. In a vehicle, the battery can match the performance of diesel or modest four-cylinder engines, but higher performance and regenerative braking can be achieved by hybridization with a high-power battery or flywheel. Because the battery is refueled with user-recycled zinc rather than recharged, it can be operated nearly 24 hours each day and requires no commercial infrastructure for its refueling.

How the battery works

Our battery has the size and shape of conventional 12-V lead-acid traction batteries, but it has over twice the energy and half the weight. Zinc particles are gravity-fed to the cells from internal hoppers and react with air to generate liquid zinc oxide products and electricity. The overall energy use of zinc-fueled electric vehicles is roughly comparable to conventional automobiles using gasoline or lead-acid batteries. Ultimately, hydrogen gas can be used in a combined chemical–electrochemical process for zinc recovery at a regional site, giving the battery a total resource conversion efficiency of a fuel cell at one-tenth the hardware cost. We have assembled an engineering prototype hybrid power unit consisting of a 7-V zinc–air battery in parallel with a 6-V lead-acid battery. This unit was operated successfully as part of the drive train of a 6-ton shuttle bus over a 75-mile, 5-hour circuit simulating its commercial use.

APPLICATIONS

- *Electric fleet and industrial vehicles*
- *Stationary power generators*

Refueling

A simple, low-cost unit refuels the batteries by hydraulically removing the reaction product from a storage tank in the battery and returning a fresh batch of zinc particles and electrolyte.

We developed engineering prototype, 6- and 12-cell, air-cooled refuelable batteries for vehicular and stationary applications.

The same equipment regenerates the zinc from the battery products. The automated refueling operation allows no human contact with the alkaline electrolyte. Zinc-recovery equipment occupying about 15 ft^2 of floor space could produce zinc at a rate sufficient to power a 6-ton bus for 24 hours a day, with an electrical efficiency of over 60%.

Applications in fleet electric vehicles

The combination of low initial hardware cost ($50–75/kW), refueling capability, and high energy density and the elimination of industrial infrastructure requirements give this battery an economic advantage over fuel cells or secondary batteries in many electric vehicle applications. This battery will greatly enhance the feasibility of fleet electric vehicles such as vans and busses by increasing their range and allowing nearly continuous use for rapid payback. We also see important near-term applications in taxis, industrial vehicles (such as forklifts and airport equipment), and stationary power sources.

Availability: An engineering prototype battery has been developed and successfully demonstrated on an electric bus. We are seeking an industrial partner to commercialize the battery.

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